

Application No. 10/675,264

### **REMARKS**

Appreciation is extended to the examiner for the thoroughness of the search upon which the outstanding office action was based. The claims as now presented fully distinguish the invention over the cited art. Claims 6, 7 and 17 – 23 are now in the application. Claims 1 – 5 and 8 – 16, withdrawn based on restriction requirements, are now cancelled.

Independent Claim 5 was rejected under Section 102 as anticipated by Chow et al. In rejecting the claim the office action referenced col. 8, lines 45-58 and col. 9, lines 7-30. To more clearly distinguish the invention over the art of record, claim 17 and claim 23 are now presented in lieu of cancelled claim 5. Claims 17 and 23 are each directed to the same class of subject matter (Group II) as was claim 5, but claims 17 and 23 each include additional features which fully distinguish over the prior art. Several of the distinctions presented in claims 17 and 23 are now noted. In view of the remarks which follow allowance of the application is requested.

### **APPLICANTS' CLAIM 17 IS NOT ANTICIPATED BY THE PRIOR ART**

The method of Claim 17 is directed to the combination of (1) etching portions of a metal layer and (2) removing residue which results from etching the metal layer. This is quite different from the disclosure of Chow et al.

As described at col. 8, lines 45 – 58, the Chow reference only discloses a limited group of examples for which:

“a process gas comprising etchant gas for etching the substrate is introduced into the chamber 30 ... for etching the layers on the substrate 25 ...”

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Specifically, the invention of claim 17 differs from the limited group of examples disclosed by Chow et al. because Chow et al. only suggests the following set of layer materials in association with substrate etching:

silicon, gallium arsenide, silicon dioxide, silicon nitride, polycide (including tungsten silicide and cobalt silicide), polysilicon, tantalum silicide, titanium silicide, molybdenum silicide.

See Col. 8, lines 6 – 30. The above group includes metal silicides, but does not include metal layers. Applicants recognize and acknowledge that metal layers and metal silicides are distinct groups. See, for example, page 1, paragraph 2 of the patent specification which separately identifies metal and metal silicide materials.

In contrast to Chow et al., claim 17 is directed to etching of a metal layer containing Al or Cu. This is different from etching of, for example, a metal silicide as disclosed in the Chow reference.

To further illustrate this distinction see, for example, the text at col. 15, lines 7-30 of Chow et al. which was relied upon for the rejection of cancelled claim 5. That is, the Chow reference only concerns

"an oxygen containing plasma [that] can be used to remove the remaining *silicon dioxide containing and fluorocarbon based* polymer residue 310 ...[Col. 15, lines 7 – 10, Emphasis Added.]"

but the claimed method only relates to formation of a polymer residue which results from :

"etching the metal layer by providing an etchant gas in the chamber comprising Cl<sub>2</sub>, BCl<sub>3</sub> or CHF<sub>3</sub> or a mixture thereof ...[Emphasis Added]"

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The scope of the Chow reference and the scope of claim 17 are mutually exclusive. The Chow reference does not include etching of metal, and claim 17 does not involve any of the materials disclosed at col. 8, lines 6 – 30 of the Chow reference. None of the materials which are etched according to the Chow reference are metal layers.

It is only the applicants who teach the claimed combination of

“etching the metal layer ... [with] an etchant gas comprising  $\text{Cl}_2$ ,  $\text{BCl}_3$  or  $\text{CHF}_3$  ...”

and

“providing a gas in the chamber, comprising  $\text{O}_2$ , O, NO or  $\text{NO}_2$  ...”

APPLICANTS' CLAIM 23 IS NOT ANTICIPATED BY THE PRIOR ART

The method of Claim 23, like claim 17, is directed to a combination of (1) etching portions of a metal layer and (2) removing residue which results from etching the metal layer and therefore differs from the disclosure of Chow et al. for reasons already explained with reference to claim 17.

In addition, the scope of claim 23 is even narrower than the scope of claim 17, requiring the combination of

“ ... etching the metal layer with an energized form of  $\text{Cl}_2$  or  $\text{BCl}_3$  or a mixture thereof, said etching resulting in formation of the polymer residue; and

providing a gas in the chamber, comprising  $\text{O}_2$ , O, NO or  $\text{NO}_2$  or a mixture thereof.”

Support for this language is found in the specification at page 4 which states:

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"The metal etching step may comprise subjecting a substrate comprising a metal containing layer thereon with an energized gas such as  $\text{Cl}_2$ ,  $\text{BCl}_3$  or  $\text{CHF}_3$ , or mixtures thereof."

In contrast to the art of record, method of claim 23 relates to formation of a polymer residue which results from

"etching the metal layer with an energized form of  $\text{Cl}_2$  or  $\text{BCl}_3$  or a mixture thereof"

For reasons in addition to those discussed above with regard to claim 17, the scope of the Chow reference and the scope of claim 23 are mutually exclusive. The Chow reference does not include etching of metal. Claim 23 does not involve fluorocarbon-containing etchants. Therefore claim 23 does not involve removal of *silicon dioxide containing or fluoride-containing* residues which are known to result when certain etchants (like  $\text{CF}_3$  or  $\text{CHF}_3$ ) are applied to the types of layers disclosed at col. 8, lines 6 – 30 of the Chow reference.

The Chow reference does not teach or suggest applying etchants like  $\text{CF}_3$  or  $\text{CHF}_3$  to metal layers, but even if it did, the scope of claim 23 does not include polymer residues which results from these species. Rather, the polymer residue of claim 23 only result from "an energized form of  $\text{Cl}_2$  or  $\text{BCl}_3$  or a mixture thereof"

**APPLICANTS' INVENTION IS NONOBVIOUS OVER THE PRIOR ART**

Claim 7 was rejected over Chow et al. in view of Reichelderfer or Harafuji. In view of the distinct subject matter now presented in independent claim 17, from which claims 6 and 7 now depend, neither of these combinations is sufficient to reject any of the claims. It is respectfully urged that, for at least two

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reasons, it would be improper to combine either of the secondary references Reichelderfer or Harafuji with Chow et al. in order to meet the terms of applicants' claims.

First, Chow et al. does not relate to etching of metal layers. There is no basis for combining references which involve etching of chemically different materials.

Second, for reasons already presented in the Specification at page 4, lines 8 – 13, it would not be obvious to use  $\text{Cl}_2$  or  $\text{BCl}_3$  or  $\text{CHF}_3$ , either followed by or in conjunction with an oxygen-containing gas. This is because, as explained in the Specification, the conventional metal etch process includes  $\text{N}_2$  (see also page 6, line 10 of the Specification) and corrosion has been shown to occur when using oxygen-containing gases during or after the metal etching stage. Therefore, none of the oxygen-containing gases presented in claim 17 (or disclosed in the Chow et al. reference) would be recognized as a suitable gas for use in combination with the metal layer etching described in any of the secondary references. Rather, it is only the applicants who recognize that, according to the method of claim 17, an oxygen-containing gas does not corrode the metal on the substrate. See again the Specification at page 4, lines 8 – 13.

For all of these reasons, the invention of claim 17 is different and nonobvious over the Chow reference whether applied alone or in combination with the other art of record. For similar or identical reasons the invention of claim 23 is also nonobvious over the art of record.

**EACH OF THE DEPENDENT CLAIMS INCLUDES SUBJECT MATTER WHICH  
FURTHER DISTINGUISHES OVER THE ART OF RECORD**

Claim 6 incorporates the express teaching that the gas must consist "essentially of  $\text{O}_2$ ." Claim 7 requires that the metal layer "comprises Aluminum." None of the prior art teaches or suggests such a method for etching Aluminum.

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Claim 18 requires the novel combination in which the claimed gas "cleans the polymer residue" which "results from etching portions of a metal layer."

According to claim 19 "an oxygen plasma [is used] to clean the polymer residue from the substrate. Claim 20 incorporates the gas "as part of a dechucking operation." Claim 21 requires that the gas be "a mixture comprising two or more species ..." According to claim 22, "the step of providing the gas in the chamber includes dechucking the substrate with the gas taken from the group consisting of O<sub>2</sub>, O, NO and NO<sub>2</sub>."

All of the dependent claims provide a unique combination of features not taught or suggested in the prior art.

### CONCLUSIONS

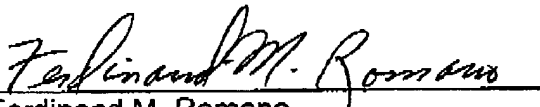
The claims have been amended to fully distinguish the invention over the prior art. In reconsidering the application, the examiner is requested, in particular, to consider the following three summary points:

1. The Chow patent does not at all relate to etching of metal lines.
2. The combination of chemistry recited in the claims is not obvious because it was believed in the prior art that use of an oxygen-containing gas after the metal etch would result in corrosion of the metal lines.
3. None of the prior art suggests an oxygen-containing dechuck gas in a metal etch process.

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For all of these reasons, none of the prior art, alone or in combination, renders the claimed subject matter obvious. Allowance is respectfully requested.

Respectfully submitted,

  
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CERTIFICATE OF TRANSMISSION

I HEREBY CERTIFY that this Response To Office Action is being FAXED to the U.S. Patent Office at 571-273-8300 (Central Fax Number) on this 15<sup>m</sup> day of March, 2006.

  
Ferdinand M. Romano